8.2 Routes of Exposure

Exposure pathways for hazardous materials and radionuclides are directly related to the nature of the project, principally, the probe installation and sampling activities. Engineering controls (glove bag), continuous monitoring, specialized training, and procedural work controls will largely mitigate the potential contact and uptake associated these tasks; however, the potential for exposure exists. Exposure pathways include the following:

- Inhalation of radiologically contaminated organic compounds and fugitive dusts during intrusive probe installation activities and sampling tasks. This contamination form may have trace amounts of inorganic compounds, and be contaminated with radionuclides, resulting in potential lung deposition.

- Skin absorption and contact with radiologically contaminated organic and inorganic compounds during drilling and sampling tasks that can be absorbed through unprotected skin or corrosion resulting in chemical bums, uptake through skin absorption, and/or skin contamination.

- Ingestion of radiologically contaminated organic and inorganic compounds adsorbed to dust particles or waste residues adhering to drilling or sampling equipment leading to potential uptake of contaminants through the gastrointestinal (GI) tract that result in GI irritation, internal tissue irradiation, and/or deposition to target organs.

- Injection, while handling radiologically contaminated organic and inorganic materials, by breaking of the skin or migration through an existing wound, resulting in localized irritation, contamination, uptake of soluble contaminants, and deposition of insoluble contaminants.

8.3 Environmental and Personnel Monitoring

The potential for exposure to radiological and nonradiological hazards exists during many of the tasks that will take place at OU 7-13/14 integrated probing project sites and affects all personnel who work in the designated work areas. Refinement of work controls zones (see Section 7), engineering and administrative controls, proceduralized work controls, worker training, and the use of protective equipment will eliminate or mitigate most of these hazards. However, given the nature of the intrusive tasks (drilling) and that sample material will be brought from the waste region to the surface (having been filtered through porous stainless steel or HEPA inline filters), monitoring with direct-reading instruments will be conducted to provide RadCon and IH personnel with real-time data to assess the effectiveness of these engineering and work controls.

Type-B probe installation and sampling activities present the greatest potential to encounter buried waste contaminants. The IH and RadCon personnel will focus on these activities and monitor them with direct-reading instrumentation, swipes, and full and partial-period air sampling (as deemed appropriate). Monitoring will be conducted to verify the integrity of Type-B probe components and interface with the sampling glove bag to ensure contamination has not migrated from the isolated lines that are to be used to collect samples, and to verify the effectiveness of decontamination practices (when required).

Personnel working at the OU 7-13/14 integrated probing project site may be exposed to hazardous materials or hazardous physical agents, as already described. Safety hazards and other physical hazards will be monitored and controlled as outlined in Subsection 8.5 of this HASP. The specific hazardous agent exposures that will be monitored are listed in Table 8-5.

8.3.1 Industrial Hygiene Monitoring

Several of the substances listed in Table 8-4 have an American Conference of Government Industrial Hygienists (ACGIH)(1999)-TLV "skin" notation indicating that a potential, significant contribution to the overall exposure may be by the cutaneous route. This includes the mucous membranes and the eyes, either by contact with vapors or, of probable greater significance if permeation or damage to PPE occurs, by direct skin contact with the substance.

Table 8-5. Operable Unit 7-13/14 integrated probing project hazards to be monitored.[a]

Task or Activity	Radiological and Nonradiological Hazards to be Monitored
All tasks	Heat and Cold Stress
Mobilization, site preparation, soil gas surveys, and geophysical mapping	Radiological contamination (alpha, beta, gamma) airborne radioactivity (alpha, beta, gamma) radiation fields (beta, gamma) hazards noise levels (heavy equipment)
Probehole installation, downhole logging	Radiological contamination (alpha, beta, gamma) Airborne radioactivity (alpha, beta, gamma) Radiation fields (gamma and neutron) VOCs[b,c] Carbon monoxide (if generator used for supplemental power) Hazards noise levels (heavy equipment)
Type B sampling (if conducted)	Radiological contamination (alpha, beta, gamma) Airborne radioactivity (alpha, beta, gamma) Radiation fields (gamma and neutron) VOCs[b] Chlorinated organic volatile compounds (carbon tetrachloride, 1,1,1-trichloroethane, trichloroethylene, methylene chloride tetrachloroethylene)"

a. **Monitoring and sampling will be conducted as deemed appropriate by project IH and RadCon personnel based on specific tasks and site conditions.**

b. **All VOCs will be monitored with direct-reading FID or photoionization instrumentation (PID) (lamp eV in accordance with the IH) to provide a single value for comparison to the VOC listed on Table 8-7 (PPE Level C or D only).**

c. **All chlorinated VOCs will be evaluated with a FID or PID (11.7 eV lamp) initially, then detector tubes if levels are suspected to exceed the action limit established for carbon tetrachloride listed on Table 8-7 (PPE Level C or D).**

eV = electron volts
FID = flame ionization detector
IH = industrial hygienist
PID = photoionization instrumentation
PPE = personal protective equipment
VOC = volatile organic compound

Various direct-reading instruments and other semi-quantitative detection tests (detector tubes) will be used at the discretion of the **M** to determine the presence of nonradiological and other physical agents. The frequency and type of sampling and monitoring will be determined by changing site conditions, direct-reading instrument results, observation, and professional judgment. Instruments and sampling methods listed in Table 8-6 will be used by the project **M** as deemed appropriate.

All full and partial period airborne contaminant samplings will be conducted using applicable NIOSH or OSHA methods, in conformance to the ***ZNEEL Safety and Health Manual,*** Manual 14B. **Risk** assessments for task-site personnel will be conducted according to MCP-153, "Industrial Hygiene Exposure Assessment.''

Table 8-6. Equipment available to monitor Operable Unit 7-13/14 integrated probing project radiological and nonradiological hazards [a].

Chemical or Radiological Hazard to be Monitored or Sampled	Equipment and Monitoring and Sampling Method
VOCs (listed on Table 8-3) Aromatic VOCs (listed on Table 8-3) Chlorinated VOCs (listed on Table 8-3)	Personal sampling pumps with appropriate media — VOCs—NIOSH 1300, 1400,2000 Aromatic VOCs—NIOSH 1501 Chlorinated VOCs—NIOSH 1003
VOCs and chlorinated VOCs (screening)	FID or PID (10.6 or 11.7 eV lamps per IH)
Chlorinated VOCs (above action limit)	Dreager, or equivalent detector tubes (carbon tetrachloride) – for level D or C PPE only
CO	MSA-361 or equivalent, with CO cell
Radiological contamination (alpha)	Count-rate—Bicron/NE Electra (DP-6 or *AP-5* probe) or equivalent Stationary—Eberline RM-25 (HP-380AB or HP-380A probe) or equivalent CAM—ALPHA 6-A-1 (in-line and radial sample heads, pump, RS-485) or equivalent (as required) Grab Sampler—SAIC H-810 or equivalent
Radiological contamination (beta and gamma)	Count-rate—Bicron NE/Electra (DP-6, BP-17 probes) or equivalent Stationary—Eberline RM-25 (HP-360AB probe) or equivalent CAM (beta)—AMs-4 (in-line and radial head, pump RS-485) or equivalent (as required) Grab Sampler—SAIC H-810 or equivalent
Radiological contamination (general counting)	LB-5100/NFS-RPS counting system or equivalent Alpha/beta scalars protean equivalent
Personal contamination monitors	Eberline PCM-2 or PCM-1C or equivalent
Radiation (gamma and neutron) fields and Geiger-Mueller (GM) instruments	Ion chamber—Eberline RO-20 with RO-7 (2,200, and 20,000 probes) or equivalent GM dose rate—Ludlum 2241 (HP-270 probe) or equivalent Neutron—Eberline E-600 with **NRD** or equivalent Electronic dosimetry—SAIC PD-3I with reader and RCIMS station or equivalent
Hazardous noise levels (>85 dBA, >140 impact)	ANSI Type S2A sound level meter and/or ANSI S1.25-1991 dosimeter (A-weighted scale for TWA dosimetry, C-weighted for impact dominant sound environments)
Heat and cold stress	Heat stress—WBGT, body wt, fluid intake — Cold stress—ambient air temp., wind chill charts

a. Air sampling will be conducted as deemed appropriate by project Industrial Hygiene and Radiological Control personnel, based on initial direct-reading instrument data, swipes, and other site factors.

8.3.1.1 Industrial Hygiene Instrument and Equipment Calibration. All monitoring instruments will be maintained and calibrated in accordance with the manufacturer'srecommendations, existing IH protocol, and in conformance to the INEEL ***Safety and Health Manual,*** Manual 14B. Direct reading instruments will be calibrated prior to daily use, at a minimum, and more frequently as determined by the project IH. Calibration information, sampling and monitoring data, results from direct-reading instruments, and field observations will be recorded per Subsection 3.1 of this HASP.

8.3.2 Radiological Monitoring

The radiological inventory of the SDA pits includes nuclides that emit alpha, beta, gamma, and neutron forms of ionizing radiation. During OU 7-13/14 integrated probing project tasks, the potential exists for exposure to both external (penetrating ionizing radiation [gamma, neutron, and high-energy beta]) and internal radiation (inhalable, ingestible, or absorbed radioactive contaminants). The greatest potential for external radiation exposure will to personnel in close proximity to the logging sources, neutron generator, or if contamination is encountered. Internal radiological hazards will only be a concern if contamination is encountered and for those personnel in direct contact with the waste constituents that are collected from the Type-B probes (samplers).

Based on the unique and distinctive hazards presented by both external and internal radiation sources, they will be evaluated, controlled, and monitored individually (although the detection of any radionuclides will serve to alert for the presence of both). For purposes of this monitoring section, they will be discussed separately and distinguished by their primary health effects (i.e., radiation [external], contamination [internal]). Radiological monitoring to be conducted at OU 7-13/14 integrated probing project sites may include area airborne equipment and personnel monitoring. When monitoring is conducted, it will be done in accordance with MCP-139, "Radiological Surveys," MCP-357, "Job-Specific Air Sampling/Monitoring," and MCP-425, "Surveys of Materials for Unrestricted Release and Control of Movement of Contaminated Material."

8.3.2.1 Radiation Monitoring. Sources for external radiation hazards include elevated background levels from SDA buried-waste pits, potential "shine" from probes, Pit 17 operations, its, logging neutron generator, and the handling of radioactive sources (calibration and active logging). Due to a variety of potential external radiation sources, a variety of area and personnel monitoring methods will be used. These may include the use of direct-reading radiation detectors (e.g., ion chambers, Geiger-Mueller [GM], and neutron), TLD, albedo (neutron dose from logging source), and electronic dosimetry. This data will be used by RadCon personnel to (1) evaluate the effectiveness of engineering controls and interlocks (neutron generator), (2) ensure radiological area boundaries are adequate, **(3)** alert project personnel to potential high radiation sources, and (4) ensure the effectiveness of decontamination methods and procedures.

8.3.2.2 Contamination Monitoring. The greatest potential for radioactive contamination will be from the TRU-contributing alpha emitters associated with the SDA buried waste. Alpha contamination is of particular concern due to its mobility, the difficulty in detection, and therefore, ease of cross-contamination. Due to the presence of beta-gamma-emitting radionuclides, beta-gamma-radioactive contamination is also a concern. Contamination monitoring for alpha and beta-gamma-radioactive contamination will be accomplished using extensive direct survey and swipe/counting techniques. Low background alpha-beta counters, located near OU 7-13/14 integrated probing project sites (or in WMF-601), will be used to quantify contamination levels. This data will be used by RadCon personnel to (1) evaluate the effectiveness of engineering controls, (2) ensure radiological area boundaries are adequate, **(3)** alert project personnel of contaminated equipment or areas, and (4) ensure the effectiveness of personnel and equipment-decontamination procedures (if implemented).

The need for airborne radioactivity sampling will be evaluated per MCP-352, "Determining Radiological Monitoring Requirements," and performed in accordance with MCP-357, "Job-Specific Air Sampling/Monitoring." The nature of the sonic drilling process, as it advances downward, tends to form a stable matrix to "fix" contaminants and minimize upward migration along the outer surface of the casing; however, air monitoring will be conducted as stated in the RWP. The Type-B probe sampling will be conducted in a confinement glove bag, and contamination monitoring will be conducted during all sampling activities

8.3.2.3 Radiological Instrument and Equipment Calibration. Radiological control personnel may use any of the radiation and contamination detectors and counters listed on Table 8-6 to provide radiological information to OU 7-13/14 personnel. Daily operational and performance checks will be performed on all portable survey instruments to ensure they are within the specified baseline calibration limits. Accountable radioactive sources (including any logging sources) will be maintained in accordance with MCP-137, "Radioactive Source Accountability and Control." All radiological survey and monitoring equipment will be maintained and calibrated in accordance with the manufacturer's recommendations, existing RadCon protocol, and in conformance to MCP-93, "Health Physics Instrumentation," and in accordance with 10 CFR 835.703(d).

8.3.2.4 External Dosimetry. Radiological dosimetry will be required for personnel working on SDA OU 7-13/14 integrated probing project sites. The RWMC requirements state that individuals leaving the administrative control area into the TSA or SDA must wear a personal dosimetry TLD. Based on these requirements, all personnel who enter the SDA project area will be required to wear personal dosimetry. Dosimetry for personnel entering the EZ during drilling, logging, or sampling will consist of a basic TLD and an electronic dosimeter (direct-reading dosimeter). Thermoluminescent dosimeters will be worn "face out" (beta window exposed) and have an albedo dosimeter attached to the bottom. Specific dosimetry requirements will be stated in the RWP. The Radiological Control and Information Management Systems (RCIMS) will be used at the project work site to track external radiation exposures to project personnel. Individuals are responsible to ensure that all required personal information is provided to RadCon personnel for entry into RCIMS and to log in each day.

Unless otherwise directed by the RWP, personal dosimetry devices shall be worn on the front of the body between the shoulders and the waist. When circumstances are such that other parts of the body may receive significantly greater doses, the RWP may instruct personnel to wear the dosimeter in a more representative position, or may specify supplemental dosimetry.

8.3.2.5 Internal Monitoring. Internal radiation sources (removable and airborne contamination) may be encountered at probing and sampling project sites. The purpose of internal dose monitoring is to demonstrate the effectiveness of contamination control practices and to document the nature and extent of any internal uptakes that may occur. To indirectly measure the amount of radioactive material present inside the body, whether from naturally occurring or inadvertent uptakes, whole body counters and bioassay samples may be used. From these measurements, an internal dose may be calculated.

The estimated internal dose shall be based on bioassay data rather than air-concentration values, unless bioassay data are unavailable. If such data are not available, it will be based on representative air concentration values in accordance with 10 CFR 835.209(c). Internal dose evaluation programs shall be adequate to demonstrate compliance with Table 2-1 of 10 CFR 835(d). Operable Unit 7-13/14 integrated probing project personnel are responsible to submit all required bioassay samples upon request.

Baseline, event-based, and project-termination internal monitoring may be used to indirectly measure any deposited radioactive material in the body for field team members with the highest potential for internal uptake (e.g., samplers, driller helpers). Other field team members, who may not directly

handle contaminated materials, may receive baseline and project-termination whole-body counts. All internal radiological monitoring requirements will be identified in the RWP.

8.3.3 Exposure Action levels

To prevent and mitigate potential personnel exposure to radiological, nonradiological, and physical hazards at the project site, ALs have been established for contaminants that have been evaluated and determined to present the highest exposure potential. Action levels, and associated responses, are listed on Table 8-7. If ALs are reached, personnel will take the appropriate action as stated. For upgrading PPE, the threshold (i.e., protection factor) for the particular level being worn must be exceeded, or another type of contaminant introduced, to justify PPE modification (i.e., full-face air-purifying respiratory protection offers the respiratory protection factor of 50, so the contaminant must exceed 50 times the TLV for an upgrade to be warranted).

8.4 Physical Hazards Evaluation, Control, and Monitoring

The physical hazards present at OU 7-13/14 integrated probing project sites and the methods that will be used to monitor and control them are described in this section. It is critical that all personnel are aware and understand the nature of the tasks that will be conducted, the equipment to be used, and the controls in place to eliminate or mitigate potential safety hazards.

8.4.1 Temperature Extremes

Project activities will be conducted year-round where there is a potential that both heat and cold-stress factors could affect task-site personnel, based on ambient air temperatures and layered PPE.

8.4.1.1 Heat Stress. Heat stress may result from outside temperatures during summer months and if personnel are required to wear protective clothing that prevents the body from cooling. High ambient air temperatures can result in increased body temperature, heat fatigue, heat exhaustion, or heat stroke that can lead to symptoms ranging from physical discomfort, unconsciousness, to death. Personnel must inform the FTL or HSO when experiencing any signs or symptoms of heat stress or when observing a fellow employee ("buddy") experiencing them. The MCP-2704, "Heat and Cold Stress," and Table 8-8 of this section further describe heat stress hazards.

Monitoring for heat stress conditions shall be performed according to MCP-2704, "Heat and Cold Stress." Depending on the ambient weather conditions, work conditions, type of PPE worn, and the physical response of work operations personnel, the IH/RCT shall inform the FTL of necessary adjustments to the work and rest cycle. Additionally, physiological monitoring may be conducted to determine if personnel are replenishing liquids fast enough. A supply of cool drinking water will be provided in designated eating areas and consumed only in these areas. Workers may periodically be interviewed by the IH, RCT, or HSO to ensure that the controls are effective and that excessive heat exposure is not occurring.

Individuals showing any heat exhaustion symptoms listed in Table 8-8 will (1) stop work, ***(2)*** exit the work area, **(3)** be decontaminated (as appropriate), (4) remove protective clothing, *(5)* move to a sheltered area to rest, (6) be provided cool drinking water, and (7) be monitored by a medic, or CPR-, or first-aid-trained employee.

Personnel exhibiting signs or symptoms of heat stroke will be immediately transported to the nearest medical facility for medical attention. Section 11 details additional emergency situations and associated responses.

Table 8-7. Action levels and associated responses for Operable Unit 7-13/14 integrated probing project hazards.

Contaminant or Agent Monitored	Action Level	Response Taken if Action Level is Exceeded
Organic vapors (11.7 eV lamp)	<5 ppm in workers' breathing zone	Monitor near source for elevated levels, ensure personnel are on upwind side of source, continue to monitor.
(Applies only if not in Level C or B respiratory protection)	5-10 ppm sustained for 1 minute in workers' breathing zone	Continue working, pull CCL_4 detector tube sample. If <5 ppm, continue working, periodic monitoring (minimum = every 5 minutes). If >5 ppm, leave area until vapor dissipates, then perform continuous monitoring or don minimum of Level C respiratory protection[a] and continue working.
(Applies only if not in Level C respiratory protection)	10–25 ppm in workers' breathing zone	If episodic—leave area until dissipates, perform continuous monitoring, or don minimum Level C respiratory protection and continue working. If sustained-don minimum Level C respiratory protection[a].
	25–50 ppm in workers' breathing zone	Evacuate area and don minimum Level C respirator protection[a], continue periodic monitoring (minimum = every 5 minutes).
	> 50 ppm in work area	Evacuate area; consult FTL whether to abandon probehole.
Hazardous noise levels	<85 dBA	No action.
	85–114 dBA	Hearing protection required to attenuate to below 85 dBA (based device ***NRR).***
	a. >115 dBA b. >140 dBA	a. Isolate source; evaluate ***NRR*** for single device, double protection as needed. b. Control entry, isolate source, only approved double protection worn.
Radiation field	<5 mrem/hour	No action, no posting required.
	5-100 mrem/hour @ 30 cm §835.603.b)	Post as "Radiation Area." Required items: RW I or II training, RWP, personal dosimetry.
	>100 mrem - 500 Rad @ 100 cm (5835.603.b)	Post as "High Radiation Area." Required items: RW 11, RWP, alarming personal dosimetry, dose-rate meter, temporary shielding (as required).
	Exceed RAM alarming set point, if required (fast ringing bell, flashing red light)	Evacuate area immediately, muster at CRZ and await instruction from RadCon.
Radiological contamination	1–100 times RCM Table 2-2 values (§835.603.d)	Post as "Contamination Area." Required items: RW II training, personal dosimetry, RWP, don PPE, bioassay submittal (as required).
	> 100 times RCM Table 2-2 values (§835.603.d)	Post as "High Contamination Area." Required items: RW II training, personal dosimetry, RWP (with prejob briefing), don PPE, bioassay submittal (as required).

Table 8-7. (continued).

Contaminant or Agent Monitored	Action Level	Response Taken if Action Level is Exceeded
Airborne radioactivity	Concentrations (µCi/cc) > 10% of and DAC value (§835.603.d)	Post as "Airborne Radioactivity Area." Required items: RW II training, personal dosimetry, RWP (with prejob briefing), don PPE, bioassay submittal (as required).
	Exceed CAM alarming set point (fast ringing bell, flashing red light)	Evacuate upwind to CRZ; await RadCon.
Any failure of the glove bag or confinement system, or emergency event at OU 7-13/14 integrated probing project sites or RWMC[b]		Evacuate the area. Use emergency shut-off on drill rig. Proceed to an upwind position or assembly area as directed by RCT.

a. Level C respiratory protection will consist of a full-face respirator equipped with a combination multichemical-HEPA cartridge (i.e. MSA, GMC-H) as prescribed by the project IH. See Section 9 of this HASP, "Personal Protective Equipment," for additional Level C requirements.

b. Section 11 of this HASP, for OU 7-13/14 integrated probing project sites, details specific events and appropriate emergency responses. Any release should be considered an emergency event and require at least an evacuation of the OU 7-13/14 integrated probing project area.

dBA	decibel A-weighted	CAM	constant air monitor	DAC	derived air concentration.	RCM	radiological control manual
NRR	noise reduction rating	RW	radiological worker				

Table 8-8. Heat stress signs and symptoms.

Heat-Related Illness	Signs and Symptoms	Emergency Care
Heat rash	Red skin rash and reduced sweating	Keep the skin clean; change all clothing daily; cover affected areas with powder containing cornstarch or with plain cornstarch.
Heat cramps	Severe muscle cramps, exhaustion, sometimes with dizziness or periods of faintness	Move the patient to a cool place nearby; give the patient half-strength electrolytic fluids; if cramps persist, or if more serious signs develop, seek medical attention.
Heat exhaustion	Rapid, shallow breathing; weak pulse; **cold, clammy ~~skin~~; heavy perspiration;** total body weakness; dizziness that sometimes leads to unconsciousness	Move the patient to a cool place nearby; keep the patient at rest; give the patient half-strength electrolytic fluids; treat for shock; seek medical attention. **DO NOT TRY TO ADMINISTER FLUIDS TO AN UNCONSCIOUS PATIENT**
Heat stroke	Deep, then shallow, breathing; rapid, strong pulse, then rapid, weak pulse; **dry, ~~hot skin;~~** dilated pupils; loss of consciousness (possible coma); seizures or muscular twitching	Cool the patient rapidly. Treat for shock. If cold packs or ice bags are available, wrap them in cloth and place one bag or pack under each armpit, behind each knee, one in the groin, one on each wrist and ankle, and one on each side of the neck. Seek medical attention as rapidly as possible. Monitor the patient's vital signs constantly. **DO NOT ADMINISTER FLUIDS OF ANY KIND**

Note: Heat exhaustion and heat stroke are extremely serious conditions that can result in death and should be treated as such. Transport individual immediately to the nearest medical facility.

8.4.1.2 Low Temperatures. Exposure to low temperatures will be likely while conducting OU 7-13/14 integrated probing project activities, and can also be encountered at other times of the year if the conditions are right. Relatively cool ambient temperatures and wet or windy conditions increase the potential for cold injury to personnel. The project IH and HSO will be responsible to obtain meteorological information to determine if additional cold stress administrative controls are required. The MCP-2704, "Heat and Cold Stress," discusses the hazards and monitoring of cold stress. Table 8-9 provides the cold stress work and warm-up schedule. Personnel must follow Table 9-2 requirements for outer-layer protection, based on radiological and nonradiological hazards.

Working on snow and ice-covered surfaces presents additional cold weather hazards. Slipping, falling, and material-handling hazards increase under these conditions. Every effort must be made to ensure walking surfaces are kept clear of ice. The FTL or HSO should be notified immediately if slip or fall hazards are noted at OU 7-13/14 integrated probing project sites on walking and working surfaces.

Table 8-9. Cold stress work and warm-up schedule.

Air Temperature °F (approximate)	No Noticeable Wind		5-mph Wind		10-mph Wind		15-mph Wind		20-mph Wind	
	Max Work Period	Number of Breaks	Max Work Period	Number of Breaks	Max Work Period	Number of Breaks	Max Work Period	Number of Breaks	Max Work Period	Number of Breaks
-15" to –19"	Normal breaks	1	Normal breaks	1	75 min	2	55 min	3	40 min	4
-20" to -24"	Normal breaks	1	75 min	2	55 min	3	40 min	4	30 min	5
-25" to -29"	75 min	2	55 min	3	40 min	4	30 min	5	Nonemergency work should cease	
-30" to -34"	55 min	3	40 min	4	30 min	5	Nonemergency work should cease			
-35" to -39"	40 min	4	30 min	5	Nonemergency work should cease					
-40" to -44"	30 min	5	Nonemergency work should cease							
-45" and below	Nonemergency work should cease									

8.4.2 Noise

Personnel working at the task site may be exposed to noise levels that exceed 85 decibel A-weighted (dBA) near heavy equipment or at the open panel to the drill rig motor. The effects of high sound levels (noise) may include the following:

- Personnel being startled, distracted, or fatigued
- Physical damage to the ear, pain, and temporary or permanent hearing loss
- Interference with communication that would warn of danger.

Noise measurements (using instruments listed on Table 8-6) will be performed by the IH per MCP-2719, "Controlling and Monitoring Exposure to Noise," to determine if personnel assigned to the jobs identified are above allowable noise exposure levels. A TLV of 85 dBA (time-weighted average) will be applied to personnel exposed to noise levels over no more than an 8-hour day. This level is based on a 16-hour "recovery" period in a low-noise environment. If personnel are required to work longer than 8 hours in a hazardous noise environment, then the TLV will be adjusted to a lower value in accordance with MCP-2917, "Controlling and Monitoring Exposure to Noise." The project IH must be consulted regarding modifications to the 85 dBA 8-hour TLV value.

Personnel whose noise exposure routinely meet or exceed the allowable noise level will be enrolled in the INEEL OMP or subcontractor hearing conservation program. Personnel working on jobs that have noise exposures greater than 85 dBA will be required to wear hearing protection until noise levels have been evaluated, and will continue to wear the hearing protection specified by the IH until directed otherwise.

8.4.3 Fire, Explosion, and Reactive Materials Hazards

Fire, explosion, and reactive material hazards at the task site include combustible materials near ignition sources (hot motor or exhaust system), transfer and storage of flammable or combustible liquids in the **SZ,** and chemical reaction (e.g., reduction, oxidation, and exothermic) from incompatible waste materials. Portable fire extinguishers, with a minimum rating of **10A/60BC,** shall be strategically located at the project site to combat Class ABC fires. They will be located in **(1)** all active work areas, (2) on or near site equipment that have exhaust heat sources, and **(3)** on or near all equipment capable of generating ignition or having the potential to spark. Operable Unit **7-13/14** personnel will receive fire extinguisher training as part of this HASP training, as listed on Table **4-1.** Project personnel will not attempt to suppress fires that have evolved beyond the incipient stage.

8.4.3.1 Project Equipment Fire Hazards. Combustible or ignitable materials in contact with or near exhaust manifolds, catalytic converters, diesel heaters, or other ignition sources, could result in a fire. The accumulation of combustible materials will be strictly controlled at the project site. Disposal of combustible materials shall be assessed at the end of each shift. Class **A** combustibles, such as trash, cardboard, rags, wood, and plastic, will be properly disposed of in metal receptacles and appropriate waste containers at the project sites. Weed control measures will be implemented (as necessary) to keep vegetation cleared around project ignition sources and structures.

Diesel fuel used at the task site to fuel the drill rig, diesel heater, and for generators will be safely stored, handled, and used. Only FM/UL-approved flammable liquid containers, labeled with the content, will be used to store fuel. All fuel containers will be stored at least **15** m (50 ft) from any of the facilities (trailers) and ignition sources, or stored inside an approved, flammable storage cabinet. Additional requirements are provided in INEEL ***Safety and Health Manual-Occupational Safety and Fire Protection,*** (Manual **14A)** and MCP-5**84,** "Flammable/Combustible Liquids Storage and Handling." Portable motorized equipment such as generators, diesel heaters, and so forth, will be shut off and allowed to cool down in accordance with the manufacturer's operating instructions, prior to refueling, to minimize the potential for a fuel fire. Refueling tasks will only be conducted by qualified fuel-handling personnel.

8.4.3.2 Waste Reactivity and Fire Potential. The waste material in Pits **4, 6, 9,** and **10** contain numerous chemical compounds and materials that, if combined or commingled in their pure form, could cause a chemical reaction that would result in the release of liberated gases, reaction intermediates, and potentially, thermal energy.

There have been long-standing safety issues associated with work activities in Pit **9** (same or similar waste forms as other SDA pits to be investigated as part of the OU **7-13/14** integrated probing project). An early indication of future issues was identified during the initial drum retrieval program, which began in July **1974** and concluded in June **1978.** Based on concerns regarding the potential for explosions or fires in Pit **9** during drilling that would result in radiological releases to the aboveground environment, an independent technical review panel **(ITRP)** was formed. Experts in the areas of health physics, chemistry, explosive safety, and safety analysis reviewed the potential for such events and addressed six potential scenarios. The ITRP report summary of the scenarios and resultant evaluation are provided in Figure **8-1** below.

Table ES-1. Evaluation of scenarios.

SCENARIO	DESCRIPTION	EVALUATION
1. Drilling into a mixture of nitrate salts and hydrocarbon oils.	Drums containing sodium and potassium nitrates and hydrocarbon oils and chlorinated solvents were disposed into Pit 9. The potential for the drill to encounter a mixture of nitrates and combustible organics does exist.	Explosion beyond extremely unlikely if H_2O > 5wt%. Explosion extremely unlikely if H_2O < 5wt%. Fire extremely unlikely.
2. Drilling into a mixture of nitrate salts and graphite.	Graphite (mainly in the form of chunks and large pieces) was also placed into drums and disposed into Pit 9. There is the potential for the sonic drill to encounter a mixture of nitrate salts and graphite.	Explosion beyond extremely unlikely. Fire extremely unlikely.
3. Drilling into a mixture of nitrate salts and cellulose (wood/paper).	Large quantities of wood and paperboard containers were disposed into Pit 9 permitting the possible encounter of nitrate salts and cellulose based materials.	Explosion beyond extremely unlikely if drill bit < 150°C. Fire extremely unlikely.
4. Drilling into an intact drum containing hydrogen.	Hydrogen can be produced through radiolytic decomposition of organic materials. There is the potential for the production of hydrogen and other gases.	Explosion extremely unlikely. Fire extremely unlikely.
5. Drilling into potentially pyrophoric or reactive materials, e.g., zirconium and depleted uranium; containers of picric acid, and lithium batteries.	There is documentation and, in some cases, concerns that these materials were placed in Pit 9.	Explosion extremely unlikely. Fire extremely unlikely.
6. Drilling into pressurized cylinders containing a flammable gas.	While no documentation exists which supports the disposal of pressurized gas cylinders, this possibility was considered to be credible.	Explosion extremely unlikely. Fire extremely unlikely.

Figure 8-1. Independent technical review panel report evaluation of potential scenarios.

Any surface fire that may occur will only be fought in the incipient state (small fire extinguishable) with hand-held extinguishers. If a surface fire cannot be extinguished safely with a hand-held extinguisher, the area will be placed in a safe shut down mode and the project site evacuated, in accordance with the procedures provided in Section 11 of this **HASP.**

8.4.3.3 Preliminary Results of Cold Test Sonic Drilling for Simulated Pit 9 Wastes.

Preliminary results of cold test sonic drilling for the OU **7-10 SIA** project are also applicable to the OU **7-13/14** integrated probing project SDA locations. A sonic drilling test was conducted at the RSI (sonic drill rig vender) facility in Woodland, California from July 6 to July 9, **1998.** The purpose of this cold test was to demonstrate the safety of sonic drilling methods in representative Pit **9** waste and "worst case" waste scenarios. Accordingly, two waste cylinders were prepared with unique waste to determine the following data objectives:

1. Determine if a noncoated drill bit will spark if it were to encounter a solid carbon steel object while advancing with rotation through Pit **9**

2. Measure the temperature in simulated waste containers and the substrate, while advancing the sonic drill bit through this waste using a series of thermocouplings

3. Verify no exothermic reaction occurs during core drilling through nitrate salt, oil, and organic mixture.

The sonic drill rig was used to core through the waste contained in the test cylinders with the following results:

1. No sparks were observed or measured when the noncoated drill bit was advanced using a combination of sonic and rotational (up to 60 rpm) methods into a 3/4-in. piece of carbon steel.

2. The maximum temperature increase measured in the waste (i.e., two 1-in. thick polyethylene sheets and concrete) and substrate (soil) was 63°F.

3. The nitrate and oil, and nitrate and wood chips mixtures showed no trace of heat affect for the sonic drilling. Additionally, the nitrate mixtures were subject to direct flame from a propane torch and did not burn, even after prolonged exposure. The organic material burned as long as it was in direct contact with the flame, but did not sustain burning when the flame was removed.

Based on the results from these cold tests under "worst case" conditions, the probability of a reaction from probing through the Pit 9 waste material is considered minimal. A complete review of the California cold test is described in the ***Operable Unit 7-10 Staged Interim Action Stage I California Combustion Test Report*** (Sherwood 1999).

Additional safety analyses and heat calculations have been performed to calculate operating parameters taking into account drilling variables, such as advancement rate, oscillation frequency, and rotation. Restrictions primarily apply to the installation of Type A probes since they have a much larger surface area and require significant power output to penetrate the overburden and waste layers. These restrictions are identified in the Type-A and -B technical procedures. These restrictions are in place to ensure that the probe tip temperature does not exceed 150°C.

8.4.4 Biological Hazards

The OU 7-13/14 integrated probing project locations are in areas that provide habitat for various rodents, insects, and reptiles. Based on biological studies done at the INEEL, deer mice have been known to carry the hantavirus. The virus is present in the nesting and fecal matter of deer mice. The potential exists for project personnel to disturb nesting or fecal matter during the course of mobilization and intrusive activities. If such materials are disturbed, they can become airborne and create a potential inhalation pathway for the virus. Also, contact and improper removal of these materials may provide additional inhalation exposure risks.

If rodent nesting or excrement material is encountered, the IH or HSO will be notified immediately and no attempt shall be made to remove or clean the area. Following an evaluation of the area, an SWP will be written for disinfecting and removing the material from the project task area in accordance with MCP-2750, "Preventing Hantavirus Infection." The IH will provide the necessary guidance for protective equipment, mixing, and application of the disinfecting solution (bleach solution) and proper disposal method for the waste.

Snakes, insects, and spiders may be encountered at the project site. Common areas to avoid include material stacking/staging areas, under existing structures (e.g., trailers and buildings), under boxes, and other areas that provide shelter for snakes. Protective clothing will prevent insects from direct contact with personnel; however, repellant (DEET or equivalent) may be required during Level D activities. Areas where standing water has accumulated provide breeding grounds for mosquitoes and should be avoided. In cases where large areas of standing water are encountered, it may be necessary to

pump the areas dry or add a small concentration of nonhazardous surfactant to the water to break the surface tension (mosquito hatching phases). Consult with the project and RWMC environmental coordinator before adding surfactant to standing water areas.

8.4.5 Confined Spaces

Work in confined spaces may subject personnel to risks involving engulfment, entrapment, oxygen deficiency, and toxic or explosive atmospheres. There are no confined spaces present at OU 7-13/14 integrated probing project task sites.

If a confined space is identified and not properly posted, it will be treated as a permit-required confined space until a determination is made by an assigned safety/IH professional. Entrances shall be posted with the required danger or caution sign, per MCP-2749, "Confined Spaces." A confined space entry permit is required before an employee can enter a confined space, per MCP-2749.

8.4.6 Safety Hazards

Industrial safety hazards pose a significant, if not the most likely threat to personnel while performing OU 7-13/14 integrated probing project tasks. Section 6 of this HASP provides general safe-work practices that must be followed at all times. The following sections describe specific industrial safety hazards and procedures to be followed to eliminate or minimize potential hazards to project personnel.

8.4.6.1 Handling Heavy Objects. During probing and drilling operations, handling and maneuvering of probes, drilling cases, bits, glove bags, and various other pieces of equipment may result in employee injury. Manual material handling will be minimized through task design and use of mechanical and/or hydraulic lifts whenever possible.

If it becomes necessary to abandon probeholes, personnel may be required to handle bags of Bentonite or sand to perform mixing operations. Bags can weigh over 36 kg (80 lb) and present a serious back strain hazard. Personnel shall not lift objects over 50 lb without mechanical assistance or the help of another person, and will be trained in the proper methods in accordance with MCP-2716, "Personal Protective Equipment." In addition, the FTL or HSO will periodically review the basics of safe lifting during POD safety briefings.

8.4.6.2 Powered Equipment and Tools. All power equipment and tools will be properly maintained and used by qualified individuals according to the manufacturer's specifications. The MCP-2735, "Hand and Portable Power Tools," will be followed for all work performed with powered equipment. All power tools and equipment used outdoors will be GFCI protected.

8.4.6.3 Heavy Equipment and Moving Machinery. The hazards associated with the operation of heavy equipment include injury to personnel, equipment damage, and/or property damage. All heavy equipment will be operated in the manner in which it was intended and according to manufacturer's instructions. Only authorized personnel will be allowed in the vicinity of operating heavy equipment and should maintain visual communication with the operator. Work-site personnel shall comply with MCP-2745, "Heavy Industrial Vehicles," MCP-2743, "Motor Vehicle Safety," and MCP-2744, "Powered Industrial Trucks."

Task-site personnel working around or near the drill rig, logging truck, and other moving machinery shall comply with the appropriate MCPs and DOE-STD-1090-99, "Hoisting and Rigging." Additional safe practices will include:

- All heavy equipment will have backup alarms.
- Walking directly in back of or to the side of heavy equipment without the operator's knowledge will be prohibited. All precautions must be taken prior to moving heavy equipment.
- While operating heavy equipment in the work area, the equipment operator shall maintain communication with a designated person responsible to provide direct voice contact or approved standard hand signals. In addition, all site personnel in the immediate work area shall be made aware of the equipment operations.
- All equipment shall be kept out of traffic lanes and access ways. Equipment shall be stored so as not to endanger personnel at any time.
- All project personnel will maintain a safe distance from any of the rotational drilling components while operating.

8.4.6.4 Hoisting and Rigging of Equipment. Movement of some drill rig support materials (e.g., hydraulic line) may require hoisting and rigging tasks to be performed for loading and unloading from trailers. All hoisting and rigging of the sonic drill rig will be performed in accordance with PRD-160, "Hoisting and Rigging," and DOE-STD-1090-99, as applicable for OU 7-13/14 operations. Hoisting and rigging equipment will have evidence of a current inspection (e.g., tag) and be inspected prior to use by qualified personnel. Additionally, for mobile cranes or boom trucks, the operator or designated person shall visually inspect items such as, but not limited to, the following each day or prior to use if the crane has not been in regular service:

- All control mechanisms for maladjustment that would interfere with proper operation
- Crane hooks and latches for deformation, cracks, and wear
- Hydraulic systems for proper oil level
- Lines, tanks, valves, pumps, and other parts of air or hydraulic systems for leakage
- Hoist ropes for kinking, crushing, birdcaging, and corrosion
- All anti-two-block, two-block warning, and two-block damage prevention systems for proper operation.

Note: The operator or other designated person shall examine deficiencies and determine whether they constitute a safety hazard. If deficiencies are found, they shall be reported to the SP.

8.4.6.5 Electrical Hazards and Energized Systems. Electrical equipment and tools as well as underground/surface electrical lines may pose shock or electrocution hazards to personnel. Safety-related work practices shall be employed to prevent electric shock or other injuries resulting from direct or indirect electrical contact. If work on energized systems is necessary, these practices will conform to the requirements in MCP-2731, "Electrical Safety," MCP-3650, "Chapter IX Level I Lockouts and Tagouts", MCP-3651, "Chapter IX Level II Lockouts and Tagouts", RWMC supplemental MCPs, and Parts I through III of " P A 70E, "Electrical Safety Requirements for Employee Work Places." In addition, all electrical work will be reviewed and completed under the appropriate work controls (i.e., SWP, JSA, or work order).

Before beginning any subsurface penetrations, personnel will (1) contact the RWMC outage coordinator to obtain underground utility clearance, (2) obtain subsurface investigation clearance, in accordance with MCP-151, "Subsurface Investigations," and (3) meet the 48-hour advanced notice requirement for any surface penetration.

8.4.6.6 Working and Walking Surfaces. Operable Unit 7-13/14 integrated probing project tasks will be performed year-round. Slippery work surfaces can increase the likelihood of back injuries, overexertion injuries, slips, and falls. The SDA presents inherent tripping hazards due to uneven terrain, existing surface penetrations (i.e., probes), and conduit. Additionally, the potential for slip, trip, and fall hazards will increase during winter months due to ice- and snow-covered surfaces, combined with objects beneath the snow. All personnel will be made aware of existing tripping hazards in proximity of the drill rig and sampling locations during the pre-job briefing.

8.4.6.7 Personal Protective Equipment. Wearing PPE will reduce a worker's ability to move freely, see clearly, and hear directions and noise that might indicate a hazard. *Also,* PPE can increase the risk of heat stress. Work activities at the task site will be modified, as necessary, to ensure that personnel are able to work safely in the required PPE. Work-site personnel shall comply with MCP-2716, "Personal Protective Equipment," and MCP-432, "Radiological Personal Protective Equipment." Project PPE levels for each task are described in Section 9 of this HASP and listed in Table 9-1 of that section.

8.4.6.8 Decontamination. Decontamination procedures for personnel and equipment are detailed in Section 10 of this HASP. Due the unique nature of contamination (TRU mixed waste), the Section 10 procedures will serve as the primary decontamination method for all personnel and equipment if contamination is encountered at OU 7-13/14 integrated probing project sites. The appropriate INEEL MCPs provide additional requirements for chemical and radiological decontamination requirements.

Decontamination procedures (Section 10) and applicable MCPs must be followed and the appropriate level of PPE worn during decontamination activities. Project RadCon and **M** personnel will follow MCP-148, "Personnel Decontamination,'' and ***ZNEEL Safety and Health-Occupational Health*** (Manual-14B), MCPs, and general IH practices.

Note: If decontamination of equipment is required, the appropriate location for decontamination will be evaluated by the HSO, in consultation with RWMC RadCon personnel, based on the nature of the contamination, extent of decontamination required, and a new RWP will be written. 1

8.4.7 Inclement Weather Conditions

The inclement or adverse weather conditions that may pose a threat to persons or property at the task site (for example, sustained strong winds 25 mph or greater) electrical storms, heavy precipitation, or extreme heat or cold) will be evaluated by the FTL with input from the HSO, **M,** SP, RCT, and other personnel, as appropriate. Stop work and mitigation measures will be determined and communicated to field personnel. During all activities, OU 7-13/14 integrated probing project RadCon and **M** personnel will determine if wind or other weather conditions pose unacceptable hazards to personnel or the environment.

8.4.8 Cryogenics

Logging tool detectors require cooling with liquid nitrogen (LN2). Liquid nitrogen will be supplied to the logging tool using standard gas fittings and a feed line for each tool. **A** LN2 storage cylinder (approximately 160 L) will be filled, as required, by an INEEL commercial compressed gas vender under existing RWMC work controls. The logging subcontractor will make LN2 tool feed-line

connections to this storage cylinder. All LN2 tasks will be conducted and protective equipment worn in accordance with MCP-2736, "Cryogenic Systems," and as listed on the applicable JSA.

8.4.9 Compressed Gas Cylinders

Compressed gas cylinders containing P_{10} gas (carrier gas for scalers and PCM) and argon gas (used during lysimeter water sample collection) will be used at OU 7-13/14 integrated probing project sites. All cylinders will be stored and handled in accordance with MCP-2728, "Compressed Gases." Additionally, the SP should be consulted regarding any compressed gas cylinder storage or handling issues.

8.5 Other Task-Site Hazards

Task-site personnel should continually look for potential hazards and immediately inform the FTL or HSO of hazards so that action can be taken to correct the condition. The HSO, RCT, and FTL will be at the project site and visually inspect the site to ensure that barriers and signs are being maintained, unsafe conditions are corrected, and debris is not accumulating on the site. Periodic safety inspections will be performed by the SP or HSO in accordance with MCP-3449, "Safety and Health Inspections," using an OU 7-13/14-specific checklist. Additionally, targeted and/or required self-assessments may be performed during OU 7-13/14 operations in accordance with MCP-8, "Self-Assessment Process for Continuous Improvement." All inspections and assessments will be noted in the FTL logbook or on the appropriate checklist to be filed in the project folder.

Health and safety professionals present at the task site may, at any time, recommend changes in work habits to the FTL or HSO. However, all changes that may affect the OU 7-13/14 project written work control documents (HASP, JSAs, RWPs, and SWPs) must have concurrence from the appropriate project technical discipline representative on site and a document action request prepared, as required.